Early Journal Content on JSTOR, Free to Anyone in the World

This article is one of nearly 500,000 scholarly works digitized and made freely available to everyone in the world by JSTOR.

Known as the Early Journal Content, this set of works include research articles, news, letters, and other writings published in more than 200 of the oldest leading academic journals. The works date from the mid-seventeenth to the early twentieth centuries.

We encourage people to read and share the Early Journal Content openly and to tell others that this resource exists. People may post this content online or redistribute in any way for non-commercial purposes.

Read more about Early Journal Content at http://about.jstor.org/participate-jstor/individuals/early-journal-content.

JSTOR is a digital library of academic journals, books, and primary source objects. JSTOR helps people discover, use, and build upon a wide range of content through a powerful research and teaching platform, and preserves this content for future generations. JSTOR is part of ITHAKA, a not-for-profit organization that also includes Ithaka S+R and Portico. For more information about JSTOR, please contact support@jstor.org.

PUBLICATIONS
OF THE
Astronomical Society of the Pacific.

VOL. XV. SAN FRANCISCO, CALIFORNIA, AUGUST 10, 1903. NO. 91.

SUGGESTIONS CONCERNING FUTURE OBSERVATIONS OF THE SATELLITES OF *URANUS*.

BY PROFESSOR HERMANN STRUVE.

The Tables of the Satellites of *Uranus*, published by Professor NEWCOMB in the "Washington Observations, 1873," can, by small changes of the mean motions, be brought in tolerable agreement with modern observations. Therefore, if we content ourselves with an approximate representation of the motions of the satellites, and if we make abstraction of the changes produced by the inclinations of the orbits, by their eccentricities, the secular motions and the reciprocal perturbations of the satellites, the tables mentioned will probably be sufficient for a long time. Future observations will then only contribute to a more exact knowledge of the mean motions of the satellites and of the mass of the planet. However, particular interest is connected with the small changes mentioned, especially as we may get thereby an answer to different questions concerning our knowledge of the planet, and as we may arrive at further conclusions by comparison with other systems of satellites.

By reason of the extreme faintness of the satellites, particularly of the two inner ones, such observations can only be made with some hope of success by the most powerful instruments. Also, the southern position of the planet during the next two decades forces us to exclude the participation of the more northern observatories. But on account of the numerous great refractors which at present are at the disposition of American observatories it may be expected that the observations necessary for the researches mentioned may be procured in the near future. With this view I beg leave to submit the following suggestions.

The observations made until now have proved that the satellites of *Uranus* move approximately in one and the same plane, not changing during a considerable space of time. Supposing, then, that in analogy with other planets *Uranus* has a sensible ellipticity, and neglecting the small masses of the satellites and the inconsiderable, in this system hardly perceptible, action of the Sun, it is evident that the orbits of the satellites form only small angles with the equator of the planet. For the secular motions of the satellites only some maximum values may be fixed at present, as the ellipticity of the planet is not yet determined by accurate observations. Assuming the greatest possible value of the ellipticity $\frac{a-b}{a} = 0.1$ and the major semi-axis of the planet $a = 1''.9$, the homogeneity of the planet would lead to the following values of the yearly motion of the apsides and of the nodes:—

$$\Delta \pi = -\Delta \Theta$$

Ariel,	55°. 2
Umbriel,	17 . 7
Titania,	3 .14
Oberon,	1 .13

Then, again, supposing the relations similar to those of *Jupiter* and *Saturn,* the values mentioned ought to be diminished to their half. It is to be remarked that, accepting $\frac{a-b}{a} = \frac{1}{14}$ and the time of revolution of the planet in round numbers equal to ten hours, as with *Jupiter* and *Saturn,* we shall find nearly the same value for the well-known constant of ellipticity: $\frac{\kappa}{a^2} = \chi - \phi/2$ as with those two great planets. Of course these numbers represent only an approximate estimate of the amount of the secular motion produced by the ellipticity. The motions produced by the satellites are even less sensible, if their masses are of the same order as those of the interior satellites of *Saturn.* Considering now that the observations of the satellites *Oberon* and *Titania* present only very small deviations from circular orbits, it is evident that only by observations of the two interior satellites, *Ariel* and *Umbriel,* the eccentricities and inclinations of which may be equal to 0.02 and 1° or 2°, respectively, can a solution of the problem to determine the motions mentioned be expected in a comparatively short time.

For the observation of those two satellites it may be particularly recommended to join both with *Titania,* whose orbit apparently offers the smallest eccentricity, by measures of position-angle and distance. The direct junction of the small satellites with the center of the planet, using bright micrometer-wires, is exposed to the objection that the pointing of the satellites will be different from the pointing of the limb of the planet, on which the wire appears as a dark line. From this circumstance considerable errors depending also on the position-angle might be produced. Also the junction of the interior satellites with *Titania* will no doubt be more exact. Such measures being made during one and the same opposition in sufficient number, and being continued in the same way through several oppositions, the elements of the planes of *Ariel* and *Umbriel* (γ, θ) with their yearly changes will be found nearly independent of the supposed elements of *Titania.* The elliptic elements (e, π) can not be deduced with the same accuracy and independent of the corresponding elements of *Titania,* but even in this case we may expect to ascertain the deviation from the circular orbit, particularly as the lines of the apsides of *Ariel* and *Umbriel* will probably show considerable motion in a few years.

Similarly, the determination of the elements of the planes (γ, θ) of *Oberon* and *Titania* will be most favorably obtained by the junction of these two satellites with each other. But the deviation from the circular orbit (e, π) being very small for both satellites, will result with only small weight. To determine this it is more profitable to join these satellites directly to the planet. As it appears not quite impossible that by the most powerful instruments we might see *Oberon* and *Titania* in the feebly illuminated field, the joining of the two satellites with the limbs of the planet by rectangular coordinates x, y might be recommended. This method of measures has been executed by me several times for the satellites of *Mars* as well as of *Saturn,* with an accuracy which, some precautions being observed, will not be much inferior to the junction of the satellites with one another.

It appears that in general the elements e, π for the satellites of *Uranus* will be determined at other times than the elements γ, θ. At the present time, and during several years to come, when the orbits are wide open, we have the best opportunity for the determination of e, π, but there is no chance to determine γ, θ with more accuracy than it has already been done for *Oberon* and *Titania*. Not before ten or fifteen years will the elevation of the Earth above the orbits of the satellites diminish so far that we may proceed to a new determination of the planes and of their secular variations.

Of course, for the theory of the system of *Uranus* it would be most important to remove the uncertainty which still exists concerning the ellipticity of the planet. Also, in this regard an answer can be expected, particularly from the large refractors having the advantage of larger focal images than the smaller telescopes. In this connection attention may be called to the suggestion made by Professor SEELIGER (*Sitsungsberichte München,* Band XIV) some twenty years ago: To examine by the help of prismatic eye-pieces in what degree the determination of the diameter may depend upon the direction to the horizon. Further, it appears to me that the atmospheric dispersion may be a source of error not yet sufficiently considered, by producing a different coloration of the borders of the planet which will interfere with the uniform pointing of the micrometer-wires on the planet's limbs. This source of error, which has proved to be very important in my measures of *Saturn,* being partly physiological, can affect in different manner the measures of different observers, and may perhaps explain the considerable differences of the various determinations of the ellipticity. When the elevation of the Earth over the planes of the satellites has diminished so far that the ellipticity may be determined anew,—that is, in about ten or fifteen years,—it will certainly be necessary to attempt the elimination of the source of error mentioned by the use of a prismatic eye-piece and by executing the measures in different hour-angles and directions.

KOENIGSBERG, May, 1903.